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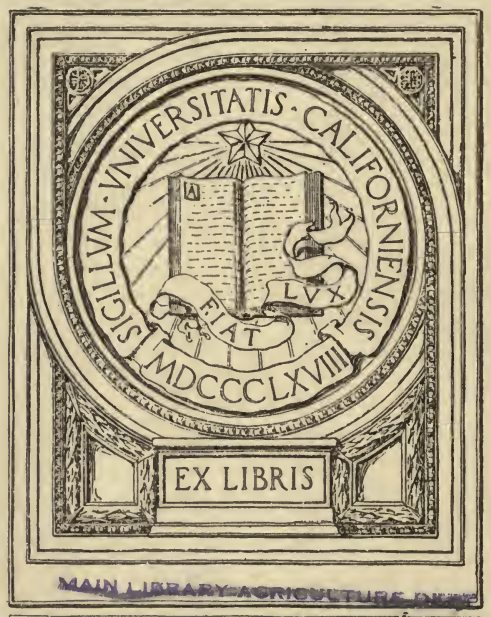

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DEPARTMENT OF AGRICULTURE,
NEW SOUTH WALES.

SCIENCE BULLETIN, No. 22.

April, 1922.

WILLIAM J. FARRER,

and the Results of his Work.

Compiled by
F. B. GUTHRIE,
At the request of the Trustees of the Farrer Memorial Fund.

Workers in the respective branches of Economic Science covered by this series of Science Bulletins will receive such of them as may be of use in their special branches of study upon application to the Under Secretary and Director, Department of Agriculture, Sydney.

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53581—A

PREFATORY NOTE.

The following notes on Mr. Farrer's life and the results of his work were compiled at the suggestion of the Trustees of the Farrer Memorial Fund, and have been approved by that body.

It was thought that, now the beneficial results of Farrer's work have been well established and recognised, the time is opportune to record the inception and progress of a work that has been of such enormous advantage, not only to New South Wales, but to the other Australian States.

Before Farrer commenced his life-work, New South Wales wheat was of a very inferior quality, and in some years, owing to drought or rust, we were actually under the necessity of importing grain for local gristing.

In those days (as the Hon. Sydney Smith recently reminded me) it was common for Government departments inviting tenders for the supply of flour to Government institutions to stipulate "best Adelaide," thereby expressly excluding the New South Wales product.

I recall, too, that in the course of an address to a gathering of farmers at Wagga Experiment Farm late in the nineties, Dr. Cobb mentioned that tenders for flour contracts had lately been invited by the French Government at New Caledonia, with the condition that the gluten-content should not be less than 9 per cent., which was 1 per cent. more than the gluten-content of the best wheat harvested in New South Wales at that time.

Among those present that day with Dr. Cobb was Mr. Farrer, then just appointed Wheat Experimentalist to the Department.

To-day the gluten-content of our f.a.q. wheat runs as high as 12·9 per cent. gluten in a very dry year, and rarely falls below 10 per cent. The credit for such a change is undoubtedly due to the late Mr. Farrer and to his successors in the plant-breeding work of the Department.

Mr. Farrer's self-imposed task of improving the flour-strength of our wheats and producing rust-resisting and drought-resisting varieties has greatly influenced both quality and yield in this, his adopted land, and has materially affected wheat production in almost every other country.

The introduction into general cultivation of Farrer's first creations in 1901–1903 opened the eyes, not only of Australian farmers, but of the world's wheat-buyers, to the possibilities of Australia as a great wheat-producing country. It was discovered that we could produce wheats suitable to the various climates in Australia—wheats that could resist diseases like rust, bunt, and smut; wheats that could resist dry conditions; wheats that were suitable to the moist coastal districts and also to the semi-arid country previously regarded as quite unsuitable for wheat production. In addition, it was discovered that we were able to produce in Australia wheats that could compete in the world's markets with the best Canadian, American, and Indian wheats, a thing hitherto undreamt of.

That is the position in which Farrer's labours have left us to-day.

The present compilation of notes on his work forms a small tribute of appreciation from the Department upon which his memory and his work reflect such distinction.

GEORGE VALDER,
Chairman of the Farrer Memorial Trust.

UNIV. OF
CALIFORNIA

MR. WILLIAM J. FARRER.

DEPARTMENT OF AGRICULTURE,
NEW SOUTH WALES.

SCIENCE BULLETIN, No. 22.

WILLIAM J. FARRER,

and the Results of his Work.

WILLIAM JAMES FARRER was born on 3rd April, 1845, and at the time of his death, from heart disease, (16th April, 1906) had just completed his 61st year.

His father was a country gentleman, living near Kendal, in Westmoreland, where he himself was born, and his family had been landowners in the district for several generations, belonging to a class known in Westmoreland and Cumberland as "statesmen."

Farrer was educated at Christ's Hospital (the "Bluecoat School"), and before leaving was one of the "Grecians," a name given to the boys in the highest form, and had distinguished himself by gaining a gold and a silver medal for mathematics.

After leaving the Bluecoat School he entered Pembroke College, Cambridge, where he graduated in 1868, obtaining a place among the Wranglers in the Mathematical Tripos of that year.

It was originally intended that he should have been called to the bar, but his own tastes did not lie in that direction, and he determined to study for medicine, remaining about a year longer at Cambridge with this object.

This idea he was obliged shortly to abandon, on account of ill-health, and it was owing to lung trouble that he sailed for Australia about 1870. His intention had been to purchase a sheep station in New South Wales, and in order to gain colonial experience he first went as tutor to the family of the late George Campbell, of Duntroon Station, near Queanbeyan. About this time, however, loss of money in mining speculations caused him to abandon the idea of station life, and to become a surveyor.

In July, 1875, he passed his examination for licensed surveyor, being placed third out of twenty-two candidates. Immediately after being licensed he was employed by the Lands Department on contract surveys in the Dubbo district, until 1878, when he paid a short visit to England.

On his return (July, 1879) he was again employed by the Lands Department in the Dubbo district, and on the survey of the travelling stock route from Nyngan to Cobar, until 1885, when he carried out surveys in the Cooma district.

In July, 1886, he voluntarily resigned his connection with the Lands Department, and settled down at his home at Lambrigg, near Queanbeyan.

He had married (September, 1882) the daughter of the late Leopold Fane de Salis, of Cuppacumbalong Station, and a prominent member of the State Legislature.

It was now that he occupied his leisure in the pursuit of the hobby which engrossed the remainder of his life. In September, 1898, his services were engaged by Mr. Sydney Smith, then Minister for Mines and Agriculture, as Wheat Experimentalist, and he continued an active officer of the Department until the day of his death.

The reasons which induced Farrer to accept this position were the opportunities of extending his experiments under different conditions as to soil and climate which were afforded him by the various Experiment Farms, and the facilities for growing on a larger scale established varieties for distribution.

Of his personal character, it is difficult for anyone who knew him at all intimately to speak without danger of being accused of partisanship. Of a highly sensitive disposition, he was by nature extremely reserved and reticent towards comparative strangers. His health, which was always somewhat delicate, accentuated this characteristic, and the fact that he had to be particularly careful in the matter of food and surroundings caused him to be always somewhat chary about accepting hospitality. Those who knew him intimately will always preserve the memory of one of the most high-minded, generous, and unassuming of men.

Widely-read and of broad culture and sympathies, his conversation was always suggestive and invigorating, and it can be quite truly said of him that no one could enjoy an intimate conversation with him without feeling a better man.

His nature was generous and sympathetic in the extreme, and none, I am sure, ever applied to him for a favour which it was in his power to bestow without its being granted, or ever related a story of suffering without enlisting his active sympathy.

He was a fluent and ready writer, and a master of English prose, so that his letters and published writings were always delightful reading; and even his official minutes possessed some literary flavour. Simple and frugal in his personal habits, he was equally direct and straightforward in his habit of thought, and was incapable of anything like self-seeking.

It was his earnest desire to benefit humanity that induced him to devote the leisure period of his life to the task of the improvement of wheat, and to put himself once more into official harness at a comparatively advanced age, in the hope of an extended field of activity and usefulness. It was this knowledge of the usefulness of the work he was doing that kept his enthusiasm undiminished to the end. He loved his work. He left it reluctantly at night, and looked forward eagerly to the morning that he might resume it.

Possessed by this untiring enthusiasm, he threw himself into his work with an energy that was quite remarkable. In the pursuit of the matter which he had in hand no labour was too exacting, no detail too insignificant. The work carried out by him on his private experiment station at Lambrigg was in itself sufficiently arduous. In addition to this, when he joined the Department of Agriculture, he supervised personally all the work done at the different farms under his direction, a task which involved the paying of

periodical visits to distant parts of the State. Both the work itself, and the actual travelling, were often done under conditions sufficiently trying to have tested the endurance of a much younger and more robust man.

Though he did not live long enough to see all his ambitions realised, he lived, nevertheless, sufficiently long to enjoy the satisfaction of public and private appreciation of his work, both here and abroad. He was in correspondence with all the English and American institutions interested in the wheat question, and he exchanged new varieties with everyone, here and abroad, who possessed facilities for giving them a trial. A few years before his death Mr. Moreland, Director of Agriculture for the North-west Provinces of India, paid a visit to Australia, under instructions from his Government, to study at first hand the methods adopted by Farrer, with a view of instituting research on similar lines in India.

The problem which he set himself was the systematic improvement of wheat by cross-breeding and selection, particularly in the direction of producing types which should resist our two principal scourges, rust and drought, and in the maintenance of a high milling standard, more especially in the production of strong-flour wheats.

By paying particular attention to this last point, Farrer not only succeeded in maintaining a high milling standard in his crossbred wheats, but produced varieties of much greater value to the miller than any that were previously in cultivation. In the matter of rust and drought-resisting varieties, his success was equally pronounced, though the establishment of a variety with such characters possesses less finality than does that of varieties of milling excellence and drought resistance. New varieties require a certain time to adapt themselves to different conditions, and many that resist rust quite successfully in one district may succumb to it in others. Then again, some rust-resistant varieties may possess qualities which render them unsuited to certain districts.

Undoubtedly it is due to the capacity of varieties that he produced to resist dry conditions that wheat-growing has become profitable in western districts where formerly it was commercially unthinkable.

The result of Farrer's life-work is that we are now in the possession of certain strains of wheat which surpass those previously in general cultivation in certain characteristics which are of supreme importance to our conditions. As these conditions prevail not only with us, but also in many other parts of the world, and as Farrer's crossbreds possess in addition the essential characteristics of being first-class milling wheats, it will be seen that his work is not merely of local but of world-wide significance.

Moreover, he advanced the improvement of wheat by cross-breeding and selection in a manner that is of great assistance to present-day plant breeders, and has already led to the cultivation of wheat in regions previously considered unsuited for it, either on account of low rainfall or liability to rust. Thus an enormous additional area has been and will be made available for wheat-growing, and the time when, according to some writers, all the available wheat-lands of the world are occupied will be yet further postponed.

It behoves us as a community to see to it that the good work begun by Farrer shall be continued in the spirit with which he conducted it.

It is given to few to realise the fulfilment of their life's endeavours, and the highest achievements of humanity are the result of the concerted efforts

of generations of workers imbued with the same idea. The torch once kindled is passed on from hand to hand, revealing to each successive bearer new wonders in the surrounding darkness.

The community can do no more than encourage those engaged in such work of love; the individual must provide the labour, and reap the disappointments and the rewards. It is not too much to hope that amongst us there may be one or more imbued with Farrer's enthusiasm, his singleness of purpose, his patience and painstaking perseverance, so that the next generation may be in possession of improved varieties of wheat, of which we at present have no proper conception. At the time of his death and as a result of his labours, Australia, if it did not actually lead the world in the production of improved varieties, stood well in the front rank.

Let it be our care that it does not drop back into a more obscure position.

CONNECTION WITH THE DEPARTMENT.

Farrer was in constant touch with the scientific officers of the Department from 1890, or even earlier. The actual work of cross-breeding and selection was carried out on his own plots at Lambrigg, Queanbeyan, which comprised under three acres, one and a half acres being available each year. It is a matter on which we are entitled to congratulate ourselves that those who were at the time in charge of the Department were possessed of sufficient intelligent foresight to realise the value to the State of the services of such an investigator. In 1898 he was offered and accepted the position of "Wheat Experimentalist." The Minister for Agriculture of the day was the Hon. Sydney Smith, the Under-Secretary Mr. D. C. Maclachlan, and the Director Mr. W. S. Campbell. As will be seen below, the original recommendation to the Public Service Board was made by the Hon. Sydney Smith. The minute to the Governor and Executive recommending the appointment was signed by Mr. Smith's immediate successor, the Hon. Sir Joseph Cook.

To these gentlemen the State undoubtedly owes a debt of gratitude, for the appointment enabled Farrer to extend his operations considerably, and placed at his disposal the resources of the Government Farms and Colleges at Wagga, Hawkesbury, Bathurst, and later Cowra. The salary attached to the position was the modest one of £350 per annum.

I mention the sum particularly because a great deal of unconsidered criticism has been levelled at the authorities for the inadequate salary offered to Farrer as Wheat Experimentalist. The remuneration was undoubtedly a very small one in view of the enormous commercial value of his achievements. It is no exaggeration to say that in the twenty years which have followed the general introduction of Farrer's wheats, millions of pounds have been saved to the farmers. At the same time it must not be forgotten that, at the time of the appointment in 1896, very little was known of his work outside wheat-breeders and a few of the Departmental officers, none of his crosses were in the hands of farmers, and no one knew anything about their possibilities as farmers' and millers' wheats except Farrer himself. Only those few who were at all intimate with Farrer had complete confidence in his being capable of effecting the improvements which he aimed at. It was because the Minister, Under-Secretary, and Director of the day were fully alive to the benefits to be derived from the closer co-operation of Farrer with the Department that the appointment was offered to him. It must also be

remembered that the salary was about the same as that then paid the Botanist and Entomologist of the Department, and further that Farrer was a gentleman of independent means, living on his own farm, and quite capable of incurring (as he had done for ten years) any expenses involved in his experimental work. Farrer himself was perfectly satisfied with the financial part of the arrangement, and was fully alive to the enormous assistance he would derive in carrying on his work by becoming a Departmental officer. It meant that he could test out his creations on different farms representative of the varying climatic conditions prevailing in the State, and so produce strains suitable to different districts instead of confining himself to his own district where very little wheat was grown. It meant that he could avail himself of large areas at the various farms on which to grow his fixed strains in quantities sufficient for distribution in a very much shorter time than he could possibly have done otherwise. For example, the first wheat, Bobs (the cross of which was made the year he joined the Department) was in cultivation by farmers on a large scale four or five years later. The same applies to Comeback and Federation. All these wheats, as the names of two of them would suggest, were named and distributed between 1900 and 1902. There were, also, assistants at the different farms working under his instructions, so that he was able to carry out experiments in many other directions beside cross-breeding.

Farrer's individuality was never sacrificed by this appointment. He was able to carry out his work in his own way and without interference, and was free from the handicap of routine-work which hampers most other scientific workers in the Government service. The appointment was one of mutual benefit to Farrer himself, to the Department, and to the farming community in whose interests both were working.

It may be of interest to quote in this place the Minister's original minute to the Public Service Board recommending Farrer's appointment. This minute indicates the lines of the general policy which the Department had in view in making the appointment:—

DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

It is now recognised that this Colony offers perhaps better natural advantages for the growth of wheat on an extensive scale than any other part of Australia, and this Department has been doing everything possible to foster and encourage the extension of the area placed under this crop. Not only has it done this, but efforts have been made to ensure as far as possible the cultivation of the very best classes of wheat, and those best suited to the varying climates and soils being planted in the several divisions of the Colony. In furtherance of this, the Department has for some years past conducted very extensive experiments in the selection, crossing and growing of wheats, and so far it is believed this has had a marked effect in improving the culture of this important cereal. Hitherto the experiments have been carried on in a highly scientific and satisfactory manner by Dr. Cobb, but his absence from the Colony makes it necessary that someone else should be at once appointed to continue and enlarge upon the experiments that have been made. This is still more necessary in view of the large areas suitable for wheat culture in the western portion of our Colony where until recently it was held that it was impossible to grow wheat at a profit. Recent developments, however, have shown that our western lands are as well adapted as any other for growing this crop on a large scale, and if operations be extended in that district it will enable this Colony in a very few years to have a very large staple export in this article of commerce.

It is important that we should experiment to ascertain what description of wheat is the best rust-resistant and at the same time possesses good milling qualities, as well as ability to withstand the heat and sudden changes of temperature of many of our inland districts, and also to prove what variety, obtained either by selection or crossing, will best resist the droughts or partial droughts of our western interior. Investigations are

also required to be made as to whether deep or shallow sowing of the various varieties will best suit the peculiarities of the climate and soils of our large alluvial plains in the Riverina and stretching across the south-western and north-western districts.

The value to the Colony of these experiments cannot be over estimated, and in view of the great possibilities of securing success a really competent man should be appointed to conduct them, and I would strongly urge that Mr. W. Farrer, who has made this question a life-long study and has achieved considerable success in a profitable way in this direction, should be approached and asked if he is prepared to continue the work commenced by the Department, with a salary at the rate of £350 per annum. This is a specialist's work altogether, and I am certain that there is no man in this or the other Colonies who is more qualified to fill the position than the gentleman I have named. Mr. Farrer, in addition to being able to conduct the experiments in the field, would render valuable aid in the solution of the problem of improving the milling and nutritive value of wheats. In this matter he would be able to work in conjunction with the chemist, Mr. Guthrie, and I feel sure that much valuable information, not alone to our farmers but to our millers and bakers, would be the result.

So far our Department has taken the lead in this branch of agricultural science as regards Australia, and it remains for us to retain that lead by keeping up and extending the useful work already performed. Mr. Farrer would also be able to undertake experiments to determine the best methods of managing the different soils in our Colony with the object of making them fertile and preventing their exhaustion with the minimum use of manures.

The Public Service Board may be asked to approve of the appointment of Mr. Farrer.

6th July, 1898. (Sgd.) S. SMITH.

THE PROGRESS OF THE INVESTIGATIONS.

For the first four or five years of his work very few people, beyond those with whom he was in correspondence, knew anything of its progress. From the commencement he was in touch with wheat-breeders in all parts of the world, and to the end he was in constant communication with breeders, growers, experiment stations, and others interested in the subject, exchanging new varieties for experimental purposes, and, what is of greater importance, interchanging ideas with others at work on similar lines. Amongst those with whom he was thus associated in the earlier days were Dr. Bancroft, of Queensland, and Professors Blount and Carleton, of America.

As his first efforts were directed towards the problem of rust-resistance he received much help from the co-operation of such authorities on rust as Professor Erikssen, of Sweden, and Messrs. McAlpine and Cobb, of Australia.

In 1890 an opportunity was afforded him of bringing his work and aims more directly under the notice of the Australian Agricultural Departments, and of obtaining official recognition of his labours. In that year, owing to the enormous damage suffered by the principal wheat-growing States through the ravages of rust (calculated to have been over £2,500,000 sterling), the Victorian Minister for Agriculture convened a Rust-in-Wheat Conference, which was attended by officers of the Agricultural Departments and others interested in wheat-growing.

Similar conferences met subsequently in Sydney, Adelaide, Brisbane, and again in Melbourne, till 1896, when they were discontinued.

To all these conferences Farrer was a regular contributor, addressing letters or reading papers of an extremely interesting and inspiring character. In a letter addressed to the first of these conferences, he states that he has "given practical attention to the subject of rust in wheat for four years" (that is since 1886), and that he first started with seed obtained from Professor Blount, who had created a large number of new crosses in Colorado.

Farrer himself, in subsequent publications, stated that the idea of systematic crossing for rust-resistance was first suggested to him in the course of a controversy on this subject between himself and the *Australasian* newspaper in 1882, the *Australasian* having maintained that such a course was not practicable. Newspaper or epistolary controversy was always one of Farrer's strong points, and he delighted in literary conflicts, in which his clear and ordered brain and ready pen made him a redoubtable opponent.

He commenced, as we have seen, experimental work on his farm at Lambrigg in 1886.

His first attempts at cross-breeding were made in 1889. Of these first crosses only one was successful, and this proved subsequently to be useless.

The area of the plots at Lambrigg, Queanbeyan, on which these investigations were carried out was under three acres, of which the two halves were made use of in alternate years. A fairly detailed account of his methods of work was given by him in his report to the Fourth Rust-in-Wheat Conference, 1894.

The first variety which he improved by selection was one of Blount's creations. To this improved wheat he gave the name of Blount's Lambrigg, a variety which he used freely in crossing. Though the original Blount's Lambrigg was never extensively cultivated, some of the varieties of which it was one of the parents have established themselves in popular favour. Wheats such as Bobs, Bunyip, Cleveland, and Firbank, all contain Blount's Lambrigg blood.

His first few years of investigation showed him that rust-resistance was a variable quality, and could be increased by breeding. He now directed his attention more particularly to increasing the gluten-content of his wheats, which characteristic was at that time generally regarded as the factor upon which depended the "strength" or baking quality of a flour.

In 1891 he wrote to the Department of Agriculture, New South Wales, asking for their assistance in examining the different wheats for their gluten-content, with the view of selecting such varieties as were richest in gluten for parents in cross-breeding.

An abstract of this letter was published in the *Agricultural Gazette of New South Wales*, Vol. 2, page 452. This assistance was promised and given, and from that time until his death he was in constant touch with the scientific officers of the Department, which he joined in the official capacity of Wheat Experimentalist in 1898.

From this time also Farrer devoted particular attention to the question of the milling value of his new varieties, rightly regarding milling excellence as a *sine qua non* of any wheat intended for grain production.

There was, however, unfortunately no means available for testing the milling quality of such small parcels (not more than a few ounces) of newly fixed cross-breeds. It was obviously quite impossible for a mill of any capacity to deal with such samples, and the millers were naturally reluctant to stop the operation of their mills in order to grind even larger parcels of new varieties of which they had no previous experience, and whose treatment would probably involve considerable alteration in their existing methods and even additions to the machinery.

At the time of the Rust-in-Wheat Conference the millers preferred therefore to deal with the type of grain then in general cultivation (soft white wheats of the Purple Straw or Steinwedel type), with whose behaviour in the

mill they were familiar, and they were in no position to offer encouragement to the production of the harder, strong-flour varieties which it was Farrer's object to breed.

As this type was exactly the one which offered the greatest resistance to rust, the efforts of the Rust-in-Wheat Conference were largely abortive, and the last conference (Melbourne, 1896) had to satisfy itself, in the final report, with classifying the wheats then in general cultivation as "rust-resistant" and "rust-escaping."

A list of the varieties then recommended is of interest at the present day, since it will be seen that twenty-five years later hardly one of them is grown to any extent, at least in New South Wales. Probably Marshall's No. 3 is the only one that has retained its popularity, Farrer's wheats or their descendants and selections having replaced the others.

A.—Rust-Resistant.—Ward's Prolific; Marshall's No. 3; Marshall's No. 8; Australian Wonder; Robin's Rust-resistant.

For cooler districts:—Blount's Lambrigg; Pringle's Defiance; Tunnack; Smith's Nonpareil.

For cooler and moister districts:—Fife-wheats such as Improved Fife and Hornblende.

B.—Rust-Escaping.—Allora Spring; Budd's Early; Early Para; Canning Downs R.R.; Early Baart.

C.—Prolific and Moderately Rust Resistant.—Talavera; Leak's; White Lammas.

It became, therefore a matter of the first importance to devise a means of obtaining reliable information concerning the milling quality of the small samples of wheat (often not more than a few ounces) which often constituted the entire harvest of Farrer's new wheats after two or three seasons.

I was fortunate enough to obtain a couple of small rolls, such as were used for grinding small quantities of whole meal, and to succeed, with the cordial help of Mr. R. W. Harris, head miller, Gillespie Bros., Sydney, in devising a method whereby the operations of a large mill could be fairly well imitated.

Although with this machine we could not hope to obtain a flour of the high-class texture and bloom of millers' flour, we were, nevertheless, able to determine with some degree of accuracy the important points of flour strength, gluten-content, and colour of the flour, as well as the proportion of bran, pollard, and flour obtainable, to bake the flour into loaves and to compare new varieties in these respects.

This information was exactly what was needed by Farrer to enable him to determine which of his new creations were worth proceeding with, and which of them were valueless. It was therefore possible for him to reject scores of varieties without being obliged to continue breeding them for years until he had obtained, for general distribution, sufficient seed of strains concerning whose milling quality he and everybody else would have been quite ignorant. Since that time these toy mills have been improved both here and abroad, and mill-products can now be obtained practically identical with the produce of the large mills. This assistance enabled Farrer to aim consistently at his objective of producing only varieties of high milling quality. The field characteristics, such as rust-resistance, suitability to dry conditions, earliness or lateness, quality of straw, and capacity for holding the grain, &c., he could, of course, study during the plant's growth.

In the final report of the Rust-in-Wheat Conference, already quoted, the attitude of the millers in this connection was discussed, and the following passage gives the view arrived at by the Conference on this point :—

"A prominent obstacle this Conference has met with has arisen from the objection of millers to use resistant wheats, and the adoption of such varieties has for that reason been retarded. . . . The opinion this Conference has long held is that the opposition of millers to such wheats has no legitimate foundation, but arises either from misconception or from conservatism. For the reason given above [in this report] this opinion has become a conviction, and this conviction the Conference wishes to make public in this report with emphasis and without reservation."

A factor which more than any other caused the millers to modify and finally overcome their opposition to the harder wheats was the necessity they were under in 1896 to import wheats in order to provide flour for home consumption. This was necessitated by the shortage of locally produced grain that season.

The wheats they imported were for the most part from Duluth (Minnesota), and were exactly of the type (Fife wheats), which Farrer had so successfully employed in his cross-breeding work. They had therefore, perforce, to accustom themselves and their machinery to deal with hard strong-flour wheats of the type which they had previously rejected, and as these wheats were recognised as being amongst those most favoured by American and English millers, our own millers were quick to realise the fact that Farrer's new wheats not only gave better farmers' crops (being rust and bunt resistant, drought resistant, and equally prolific or even better yielders than the old varieties), but were in all cases superior milling wheats.

PRODUCTION OF NEW VARIETIES.

A few notes on some of the first varieties produced by Farrer may be of interest.

Bobs.—This was the first commercially successful "Farrer" variety produced. It is a cross created in 1896 as the result of mating a sport from Blount's Lambrigg (a wheat improved by Farrer by selection from a Blount's wheat) with "Bald Skinless Barley" or "Nepaul Barley." The progeny was fixed four years later (1900) and named "Bobs." There is some doubt as to whether Bobs is a true hybrid or not. See note on Bobs in bibliography at end.

Yandilla.—This was one of the earliest crosses made by Farrer between the Fife wheats and Indian varieties, the object being to combine the milling excellence and stiff straw of the Fifes with the properties of early ripening, holding the grain in the ear firmly, and the shorter and less abundant straw that are the characteristics of the Indian wheats.

Yandilla was a cross between Improved Fife and Etawah (an Indian wheat).

This variety is important by reason of its having been the parent of two of our most extensively cultivated wheats—Federation (a Farrer wheat), and Yandilla King (produced by Mr. R. Marshall, of South Australia).

Federation.—This is the result of a cross between Purple Straw and Yandilla with the object of improving the variety of wheat then most popular by imparting to it the high milling excellence and other good qualities of the Fife-Indian strains. Its full pedigree is therefore :—

Improved Fife x Etawah

Purple Straw x Yandilla

Federation.

This has been for many years one of the most popular varieties in all the principal wheat-growing States, and has quite ousted the old Purple Straw type on account of its equal if not superior prolificness and its higher milling value. It is a good stooler, and produces the maximum amount of grain for the minimum amount of straw. Like Purple Straw, it is, however, rather rust and smut liable. Yandilla King, which has been mentioned above as a creation of Mr. R. Marshall, of South Australia, is a half-sister of Federation, having the pedigree

Yandilla x Silver King.

Yandilla King.

Silver King is a strain of Marshall's No. 3.

Hard Federation is a selection from the standard type, which has been fixed and improved by selection by Mr. J. T. Pridham, Farrer's successor. It received its name from the quality of its grain, which has a flinty appearance and does not bleach easily. This feature, together with its superior flour-making qualities, has brought it into favour with millers. It is a mid-season variety, and a heavy yielder, in addition to being a superior milling wheat to the original Federation.

Comeback is another of the early Fife–Indian cross-breeds, remarkable on account of its high milling excellence, which makes it a favourite miller's wheat. Its pedigree is as follows:—

Hornbende x Indian "A"
(a Fife wheat).

Vanessa x Indian "G."

Improved Fife x Unnamed.

Comeback.

It is an early maturing wheat, cultivated both for grain and straw. Slightly rust-resistant, and not very susceptible to bunt.

Cedar is another of the Fife–Indian crosses, containing about three-quarter Fife and one-quarter Indian blood. Its pedigree is as follows:—

Jonathan x Zaff
(Fife–Indian Cross) (Indian).

Power's Fife x Unnamed.

Cedar.

It is a mid-season variety, highly bunt and rust resistant. It is the strongest red wheat up to date and the best milling variety.

Marquis, a Canadian bred wheat that is considered to be amongst the very best for Canada and the United States has a pedigree similar to that of Cedar, being a cross between Red Fife and Calcutta Hard Red (an Indian wheat).

Other Fife-Indian crosses include Jonathan and Bomen, and there are a large number of crosses between Fife wheats and soft wheats of the Purple Straw type amongst which the most popular are Rymer, Bunyip (a cross between Rymer and Maffra), Florence and Genoa, whilst Warren, Cleveland, Thew and Firbank contain Blount's blood in addition.

Amongst the most successful hybrids in addition to Bobs may be mentioned Canberra, a cross between Federation and Volga Barley, a two-row sort obtained as an impurity in a sample of wheat received from Russia.

The following list includes practically the principal wheats produced by Farrer which have been in cultivation :—

†Bobs
Bomen
†Bayah
Bunyip
†Comeback
†Cedar
Clarendon
Cleveland
Canberra
*Cumberland
Federation
*Field Marshall
Florence
Firbank
*Farrer's Durum
Genoa
*Jade
*John Brown
†Jonathan
Jumbuck
*Nardoo
*Nutcut
*Outpost
*Plover
*Rerraf
Rymer
*Schneider
Sunset
*Sussex
Thew
*Tarragon
*Uppercut
Warren

Several of these are crosses made originally by Farrer, but which were unfixed at the time of his death. They have since been fixed and improved by selection and cultivated in the field plots for distribution. Some of them, such as Bomen, and Clarendon, have only become available to farmers during the last few years and have only been named quite recently.

It would occupy too much space to enumerate the characteristic features of the numerous wheats produced by Farrer, but they each possess or were bred for distinct characteristics which make them valuable for the different conditions prevailing in Australia. Some of them, such as Bunyip, Florence, and Firbank, are very early maturing varieties. Canberra, early ; Jonathan, Warren, and Bomen, mid-season ; Cleveland, Rymer, Genoa, late.

Jonathan is a rust-resistant wheat and was created for its suitability to the cool, moist districts. Cleveland, Florence, and Genoa are also rust-resistant. Florence was bred specially for smut-resistance. Firbank is highly drought-resistant and is an excellent hay wheat. Cedar and Genoa are resistant to bunt. Most of them are grown for both grain and hay, though one or two, such as Firbank, are particularly good for hay and green fodder, whilst others, such as Bunyip and Canberra, do not produce much hay and are grown for grain only.

Nearly all of them belong to the "soft white" class, the exceptions being Bobs and Comeback, which are "hard, white wheats" whilst Cleveland, Florence, Genoa, John Brown, Jonathan, Sussex, Tarragon, Nutcut, and Warren are "medium hard" and Cedar hard red.

With such diversity of type it is difficult to say with any definiteness which are the most popular varieties, but without doubt Federation wheat is more generally grown in New South Wales, the original type giving way gradually in some localities to the Hard Federation strain.

* Not now grown. † Grown only to a limited extent.

Federation was first made available to farmers in 1902. It became popular immediately. By 1909 one-quarter of the area under wheat in Victoria (into which State it had been introduced in 1904) was under Federation, which yielded 3 to 4 bushels per acre more than other varieties. The Victorian Director of Agriculture, Dr. Cherry, estimated the increased value of the harvest of 1909–10, due to this wheat, as £250,000, or 1,000,000 bushels.

Though a good milling wheat it is not a hard wheat, and does not produce strong flour, but the strain known as Hard Federation is a distinctly strong flour grain.

Of the wheats specially created for strength of flour Bobs was the first to be distributed. The original cross was made in 1896, and the type fixed and named four or five years later.

Mr. A. E. Humphries, past president of the National Association of British and Irish Millers, reported of this wheat that its flour was the best Australian flour he had ever handled, and compared favorably with Manitoba flour.

Comeback is a superior milling wheat to Bobs, and such a local milling authority as Mr. Kahlbaum, manager of the Adelaide Milling Company, has stated that its flour is better than the best imported Manitoba.

The best of all Farrer's creations in regard to milling excellence is undoubtedly Cedar. This is a hard berry of the same type as the celebrated Marquis. It is an equally good milling wheat, and more suitable to local conditions. At the time when the Royal Agricultural Society of New South Wales awarded annually a championship prize for the best sample of wheat exhibited, judged on its milling and general commercial value, this prize was, after 1908, always awarded to a Farrer wheat, and after 1912 invariably to Cedar. From 1908 to 1910 Bobs was the champion wheat, in 1911 Comeback, and from 1912 to 1915 Cedar. After 1915 this prize was eliminated from the schedule.

In the same way it has become necessary this year (1922) to make a special class for the Farrer wheat, Florence, because since 1916 it has taken the first prize in the medium strong flour class every year, and in most years the second prize as well.

Concerning Hard Federation, which is amongst the varieties more recently selected and fixed, and which is becoming a very warm favourite with both farmers and millers, the following note, quoted from the English journal *Milling*, of 5th November, 1921, page 514, is of interest :—

THE MILLING VALUE OF HARD FEDERATION.

Reference was made in an editorial note in our last issue to the use of Australian wheat varieties in the Pacific Coast area. Later information of milling and baking results is equally interesting. It shows that Hard Federation, which belongs to what is known as the Federation group of wheats, exceeds Early Baart, Pacific Bluestem, Marquis and Kharkof in practically all the important milling and baking factors. In weight per bushel it is exceeded by Kharkof, in crude protein of the wheat by Pacific Bluestem, and in volume of loaf by Marquis. In all other comparisons Hard Federation ranks highest. This variety has been grown commercially in Australia since 1914, and it is considered it would attract buyers and bring a premium over other wheats on Australian markets.

It is interesting to note that these Federation varieties have recently become commercially established in India. They are the most popular and prolific varieties in general cultivation in Australia at the present day, where during the last six years the golden yellow characteristic of old time Australian harvest-fields has been gradually changed to a dull bronze through the ever-increasing popularity of Federation wheat.

SOME CROSS-BREEDING PROBLEMS.

It is interesting to note that although Mendel's law (now largely the basis on which plant-breeders work) was unknown to Farrer until shortly before his death, he nevertheless recognised the possibility of combining different characteristics in the parents and segregating those particular ones he desired to perpetuate.

The following passage, which is taken from Farrer's report to the Fourth Rust-in-Wheat Conference, 1896, indicates the general lines on which he proceeded :—

In order to combine the qualities of earliness of maturity and resistance to rust in one variety by means of cross-breeding, late rust-resistant and early rust-liable sorts, as I have already pointed out, have to be mated. It will be well to pause for a moment and consider what we ought to expect from the union of types which differ so widely in these two qualities, as well as in others, such as the relative hardness, size, character of the grain, &c. What we generally see in the analagous case of the animal kingdom, with which we are more familiar, is that when parents, which are not closely similiar, are united, if the progeny be numerous, certain individuals inherit some of their characteristics almost entirely from one parent, combined with other characteristics which they have inherited almost entirely from the other parent, whilst as regards a majority of their characteristics they are intermediate in various degrees between both parents ; and when this happens in different degrees and in a different manner with all the progeny, it will be seen how it comes that no two individuals of the same parentage are ever exactly alike, and that the greater the dissimilarity of the parents the greater will be the difference between the offspring of the same union. I will attempt to illustrate briefly what I mean, and for this purpose will make the case as simple as I can, and apply it to the subject we are actually dealing with.

Suppose I have mated a rust-resistant-late with a rust-liable-early variety of wheat. The greatest diversity of types will be shown by the offspring which grows from seed of the first generation of the cross from such seed as I am distributing. Suppose we have 100 plants growing from such seeds, which are of the same parentage. Out of this number I would expect there might be one or two—say one—which has inherited in a very high degree, possibly in as high a degree as the parents themselves possessed them, the qualities we are seeking to secure from both parents. A few more—five—I would expect to inherit high rust-resistant power from one parent, associated with moderate earliness from the other ; and five more to inherit a high degree of earliness with fair rust-resisting power. The remaining eighty-nine I would expect to inherit these qualities in various degrees intermediate between the two parents ; and something of this sort is what I find actually to occur in most cases. The work then, of the person whose business it is to make use of these 100 plants is essentially the work of selecting as many of these eleven plants as promise to fill our requirements, and that work, as I have found out from actual experience, requires for its successful performance a close attention, care, patience, thoroughness, and system.

Professor R. D. Watt, Professor of Agriculture, Sydney University, to whom this excerpt was submitted, comments as follows :—

This quotation shows that, although Farrer was at that time in ignorance of Mendel's historic experiments, he was working more or less along Mendelian lines—for the main practical lesson of Mendelism is that, if two varieties of any crop, each of which possesses one desirable and one undesirable character, are crossed, there will appear amongst the progeny one or more individuals possessing the two desirable characters, and that some or all of them will breed true to both these desirable characters. The proportions mentioned by Farrer do not agree with Mendel's figures probably because resistance to rust (*Puccinia graminis*) is not a simple Mendelian factor in inheritance.

Two instances of Farrer wheats may be quoted to show how Farrer used something very closely akin to the Mendelian method. Of the many varieties he had at his disposal, a crossbred called Maffra was noted for its early maturity, which was its main asset ; Zealand was one of the best late maturing wheats for hay, and Rymer one of the best late maturing prolific grain yielders. Farrer desired to get a variety of wheat suitable for hay which would mature sufficiently early to enable the farmer to have his hay in the stack before the grain harvest commenced. He therefore crossed Zealand with Maffra, and amongst the progeny he found a few plants which combined the excellent hay qualities of Zealand with the early maturity of Maffra. From these few plants he saved the grain and sowed it in small plots, found that it bred true, and thus he evolved the variety Firbank, which is still perhaps the best early maturing hay wheat for New South Wales conditions.

His second objective was to get a prolific grain-yielding early maturing variety ; and so he crossed Rymer with Maffra. The result was Bunyip, which for a time was the most prolific grain yielder of all the very early maturing varieties, although it has been recently surpassed by newer varieties like Canberra.

It does not appear that Farrer was conversant with Mendel's work until about 1905, when it was too late for him to work on Mendelian lines. A few extracts from correspondence he carried on in 1905 with Professor R. H. Biffen, of Cambridge, will throw some light on Farrer's views on the subject. Writing under date 8th March, 1905, he says :—

In your letter you speak of "the old bugbear of fixing varieties." This work for the last twelve or fourteen years has given me no trouble whatever. It seems to me from what I can see of Mendel's theory of heredity, that the consideration I then gave to the matter of fixing varieties led me to adopt the system, which, for all practical purposes, Mendel's theory indicates as being the best. . . . . The practice was adopted from what appeared to me to be common-sense considerations ; I certainly had not Mendel's theory to work upon.

In a subsequent letter dated 14th April, 1905, he remarks :—

There is one point in connection with Mendel's law that it seems to me not to provide for. It is that when varieties, which differ sufficiently in type, are crossed, the variable generation seems to produce individuals which differ in all the qualities in which varieties differ : *e.g.*, by crossing two late sorts of different types, it is quite possible to get early sorts. I cannot recall just now an instance in which I have got a very early variety in this manner, but I have made from such crosses varieties which are distinctly earlier than either parent. Mendel's law, I fear, is not likely to be of great use to me in enabling me to improve my methods, because in nearly all the crosses I make, one of the parents is an unfixed crossbred, and frequently a plant of the first generation from the cross.

In connection with the above quotation from Farrer as to the use of unfixed cross-breds as parents, the following remarks by Mr. J. P. Shelton, holder of the Farrer Scholarship, who has recently returned from England and America, and has had the opportunity of studying, especially at Cambridge, with Professor Biffen, the present developments of wheat-breeding, are of special interest :—

The practice, adopted so largely by Mr. Farrer, of mating unfixed cross-breds, and indeed using first generation cross-bred plants as parents, was based upon the old nineteenth century conception that crossing was of value because it induced variations. It is diametrically opposed to the modern methods based on the knowledge of Mendelism, and is indeed in strange contrast and opposition to Farrer's own views and knowledge of the segregation of "unit characters."

It is not suggested that Farrer could not obtain valuable recombinations of characters by crossing F_1 plants. The pedigrees of some of his best productions show that such recombinations were obtained—fortunately for Australia. But the mathematical aspect of Mendelism based on the laws of chance shows that Farrer undoubtedly reduced, in a very large degree, the chances of obtaining any desired recombination by crossing F_1 plants, as compared with the crossing of fixed strains, or pure lines, that had the necessary characters. On the other hand, when no fixed or pure line strains were available, any success resulting from Farrer's system saved several years of patient labour, and expedited results by so much time as would have been necessary to first create and fix such varieties.

The statement that Mendel's law does not provide for cases in which the progeny of a cross includes individuals which possess characters not found in either parent was undoubtedly true, as Mendel's law was then stated and understood. Subsequent research, however, has shown that some characters depend, for their full expression, upon the presence of more than one Mendelian factor. Thus late varieties are differentiated from early varieties by the presence of several factors. Where two late varieties are crossed, it is evident that different recombinations of the several factors for lateness may occur in the variable generation. Some plants will then contain less than the full number of factors for lateness, and will show a degree of earliness in correspondence with the decrease in the factors.

Farrer's case of the appearance of early wheats as the result of crossing two late wheats of different type is therefore not really at variance with Mendel's theory as now understood ; although at the time his objection was perfectly valid.

FARRER WHEAT FOR DIFFERENT DISTRICTS.

The following interesting notes on the general cultivation of Farrer wheats, and especially their suitability for the varying climatic conditions prevailing in different parts of the State, are kindly supplied by Mr. A. H. E. McDonald, Chief Inspector, Department of Agriculture, who has a very intimate knowledge of the districts in which wheat is grown :—

Farrer displayed remarkable versatility in his work. He recognised that the characteristics of a variety limited its successful growth to certain localities, and therefore set himself the task of breeding varieties adapted to the different conditions which exist throughout the State. The magnitude of the task may be gauged from a consideration of the differences which exist between such districts as Glen Innes on the Northern Tablelands and Condobolin in the west, Wagga in the south and Inverell in the north-west. Farrer, however, succeeded and his success may be measured from the fact that to-day out of the twenty varieties recommended by the Department of Agriculture as the best, twelve are the result of his labours. Furthermore, the most suitable variety for any district is still a Farrer variety, no other varieties having displaced them from their premier position.

It is impossible to determine accurately the value of Farrer's work, yet it is undoubtedly very great. The wheat-growing industry is of the utmost importance to the State—the 1920-21 harvest was worth over £21,000,000—and its magnitude is very largely due to Farrer. The introduction of his varieties into general cultivation has caused wheat-growing to be extended westwards over a vast belt of country which before could not be cultivated, owing to the unsuitability of existing varieties.

Farrer's wheats, such as Federation, Canberra, &c., average at least 2 bushels per acre more than other kinds, and as the average yield for the State is about 12 bushels, this increase is of the utmost importance. It is really the margin of profit, and has no doubt been the decisive factor in inducing farmers to bring more land under wheat. We have come to accept as natural that wheat can be grown in certain districts, and yet if Farrer varieties could be wiped out it would be found that wheat-growing would be quite unprofitable over a very great area in the districts.

In the safer Riverina districts, Federation still remains favourite, and although it has some drawbacks—the principal being its susceptibility to rust—its supremacy has never really been challenged. Occasionally farmers appear to be swinging away from it. This is usually after an abnormally wet year, but the return of normal seasons renew its strong position. In 1919-20 the State purchased over 1,000,000 bushels of seed wheat, the buying instructions being that all sound wheat of any variety was to be bought. The quantity mentioned represented the principal portion of the harvest, and the drought-resisting qualities of Federation, and also its popularity, are indicated by the fact that 80 per cent. consisted of that variety.

The value of Farrer's work in wheat-breeding becomes more apparent in the success he achieved in breeding wheats suitable for the dry western districts. Until recent years Condobolin was regarded as being quite outside the wheat-growing belt, but by the use of Farrer's varieties, or of varieties of which he laid the foundations, wheat is now successfully grown in large areas, and the acreage is rapidly increasing. In the south-west and beyond Temora, in the districts represented by Wyalong, Ungarie, Lake Cargellico, Barellan, Ardlethan, and Binya, great areas have been included in the wheat area, principally by the use of Farrer varieties. In the western districts the extension of wheat-growing has taken place in the districts surrounding Narromine, Gilgandra, Bogan Gate, Peak Hill, Trundle, Tullamore, &c., while it is being pushed out beyond Coonamble.

In all these districts, while some local variations of soil or climate leads to a particular variety being favoured, the same general characteristics are present in all varieties. The low rainfall, with a mild winter, short spring, and early summer renders it imperative that a variety should give a good yield with a small amount of moisture, and that it shall come to maturity early.

Farrer early in his work accurately estimated the qualities which were essential in all these districts, and the most popular are such varieties as Canberra, Hard Federation, and Florence, which possess these qualities in a marked degree. Hard Federation was not actually raised by Farrer, but is a legacy of his work, being the result of skilful selection by Pridham from Federation.

Last year a number of agricultural associations conducted crop-growing competitions in the western districts, and in every case except one the winning crop was a Farrer variety. In the exception the winning crop was composed of two varieties, and one of these was a Farrer variety. This is sufficient indication of the excellence of these varieties and their popularity.

In the northern districts, while drought-resistance is of importance, it must be combined with rust-resistance and capacity to withstand the storms which are frequently experienced in this area. These qualities were combined to an exceptional degree by Farrer in Bomen, which is rightly regarded by farmers in that part of the State as very valuable.

The Royal Agricultural Society's competition for the best crop in the north-western wheat district was won last year by a field of this variety. Under the climatic conditions of last season the crops were subjected to a severe test in regard to rust and storm resistance.

While wheat-growing is not so important in the tablelands as in the western districts, Farrer has not neglected the question of providing a suitable variety, and experience has shown that for general excellence few, if any, wheats are so suitable for these districts as Cleveland, Florence, and Genoa.

Grain is not produced on the coast, but dairy-farmers in this part of the State are keenly interested in wheats suitable for green feed. In the early days of the colony wheat was grown in the coastal districts, but owing to ravages of rust its growth for many years, even for green feed, was discontinued. With the advent of Farrer varieties tests were made to determine whether wheat could not be grown for green feed, and the result has been that some, particularly Thew, have proved extremely useful, and dairy-farmers are now able to grow this crop successfully for feed during the winter and spring months.

COMMERCIAL VALUE OF FARRER WHEATS.

Some notes under this heading are kindly supplied by Mr. G. W. Walker, of Lindley Walker Co-operative Grain Co., Ltd., Sydney :—

The selection of a number of the best ears from an ordinary crop of wheat, and the grading of the grain by sieves or other machines in order to obtain the largest for use as seed, has been practised by the most advanced agriculturists in all ages. Virgil says :—

> "I've seen the largest seed, tho' viewed with care,
> Degenerate, unless the industrious hands
> Did yearly cull the largest."

Science played but a small part in the above methods of selection, and the cold calculating business mind paid slight attention to Farrer's early attempts at plant-breeding.

In the pioneering days of wheat cultivation in Australia, and practically up to 1890, all the business mind knew about wheat varieties was that the entire crop was frequently overtaken by rust. It was agreed that something would have to be done to combat the rust scourge, which threatened the wheat industry. The growers throughout the wheat States of Australia petitioned their respective Governments, and a conference of experts was convened. This Rust-in-Wheat Conference had several yearly gatherings, and the master mind of Farrer eventually dominated the proceedings. He practically ploughed the furrow alone, and yet the practical application of his theories in a short period of time revolutionised wheat-growing in this State and throughout Australia, and in fact, the success of his work did much for wheat-growing throughout the whole wheat world.

The commercial value of his work would indeed be most difficult to assess, but prior to his introduction of Bobs and Comeback, large importations of Manitoba flour were necessary. The public taste is now content with bread made solely from Farrer wheats. Not only is the Australian palate satisfied, but since the Farrer strains have figured largely in our wheat exports the value per quarter of Australian wheat has increased, and whereas, prior to Farrer's varieties, our wheat was sold at a discount of from 2s. to 3s. per quarter compared with the grain of other countries, it has, within the last ten years, met the grain of exporting countries, and at times sold at a premium over all. It would be modest to say that Farrer wheats have improved the selling value of our wheat in the markets of the world by at least 2s. per quarter, or 3d. per bushel.

Many Farrer wheats are now the favoured varieties on the Pacific Coast of the United States. They are widely grown and very popular in Chili and Peru, and Queensland's success in wheat-growing during the past two years is due almost entirely to the universal growth of Florence.

Honour to Whom Honour is Due.

I am not prejudiced against hero worship, but if I were I would still say that every man, woman, and child in the Commonwealth owes a debt to William Farrer. If every flour-miller in Australia gave £10 10s., and every wheat-grower gave £1 1s., it would be but the smallest token of gratitude to the work of Australia's greatest benefactor.

THE FARRER MEMORIAL FUND.

The following notes on the history and present position of the Farrer Memorial Trust are presented by Mr. F. H. Harvey, hon. sec. to the Trust:—

On Mr. Farrer's death the need was recognised for perpetuating his memory in some suitable form associated with his life-work. As a result of a public meeting a subscription list was opened and funds were raised amounting to £1,030. On 16th October, 1911, the money was vested in five trustees, three of whom, Messrs. G. W. Walker, Henry Lord, and F. B. Guthrie, represented the subscribers, and the remaining two, the Under-Secretary for Agriculture, and the Principal, Hawkesbury Agricultural College, represented the Government. The functions of the trustees were then laid down as follows:—

1. The trustees shall receive any subsidy or annual grant made by the Government and any further donations or bequests from other sources, and shall allocate the interest accruing from the capital fund, to be always known as the "Farrer Memorial Fund," in the form of a research scholarship, on terms to be made by them in accordance with the general conditions herein set out.

2. The proceeds of the Farrer Memorial Fund shall be devoted to the establishment of a "Farrer Research Scholarship," to commemorate the valuable services rendered to Australia in general, and New South Wales in particular, by the late Mr. William Farrer in the cause of wheat-breeding. The specific object of this scholarship shall be the improvement of wheat cultivation, using the term in its widest sense, whereby Mr. Farrer's work may be continued and results of direct and immediate benefit to the State may be secured.

3. It was thought that this object could be best achieved by encouraging research along definite lines, of which the following would be typical examples:—

Field Work.—This may be carried out on one of the farms of the Department of Agriculture, or on a private farm or estate.

Cross-breeding and Selection.—In order to produce improved varieties with a specific object, such as prolificness or resistance to disease or drought, milling excellence, flour strength, nutritive qualities, &c., also improved method of treatment of soil and crops.

Laboratory Work.—This may be carried out, according to its nature, at one or more of the University laboratories, or at one or more of the Government Departmental laboratories.

(*a*) Botanical—study of the structure of plants and grain or of different parts of same, germination, &c.

(*b*) Microbiological—study of diseases and their remedies; study of fermentation in bread-making, &c.

(*c*) Chemical—nature of the grain and of different varieties of grain; nature of flour and bread; nutritive value of bread; digestibility, &c.

Technical Work.—May be done in a mill or bakehouse, apart from or in conjunction with laboratory work. Improvements in milling or baking operations tending to improvements in the quality of flour and bread.

4. It was suggested that a candidate suitable for the original work contemplated in this scheme would be found in one of the following types of applicants:—

(*a*) A graduate in science who may desire to pursue his further studies with original research in Cambridge University laboratory or elsewhere outside the State. The revenue from the fund for two years may be given for one year's research in such a case.

(*b*) A graduate or undergraduate who wishes to pursue the study of plant-breeding in any specific direction in the University laboratories under the supervision of the Science Faculty.

(*c*) A student who has taken his diploma from the Hawkesbury Agricultural College or who has done a satisfactory course in any similar institution, and who wishes to pursue the study of plant-breeding in the field or in any other way approved by the trustees.

(*d*) A young farmer or other person who has the necessary qualifications and aptitude for investigating this subject in the field, and will do so under the supervision of the trustees, and in accordance with their regulations.

(*e*) Three years hence, and afterwards, a Government Farrer Scholar, on graduating from the Hawkesbury Agricultural College, shall have first claim for assistance from this fund, should he desire to proceed further in the direction of wheat-breeding, either in the laboratory or in the field, under conditions to be approved by the trustees.

The present trustees, 1922, are—

Mr. G. Valder, Under-Secretary and Director of Agriculture.

Mr. F. B. Guthrie, chemist, Department of Agriculture.

Mr. E. A. Southee, principal, Hawkesbury Agricultural College.

Mr. G. W. Walker, Lindley Walker Co-operative Grain Company, Ltd.

Mr. H. W. Potts (late principal Hawkesbury Agricultural College), Lindley Walker Co-operative Grain Company, Ltd.

Mr. T. I. Campbell, general secretary, Farmers and Settlers' Association.

The amount originally subscribed for the Farrer Memorial Fund has been invested in interest-bearing securities, and, with the addition of an annual grant received from the Government, the amount held on 31st December, 1921, after meeting all obligations as to scholarships, &c., amounted to about £2,000. The trustees have applied the revenue from the fund towards carrying out the original objects for which the subscriptions were raised.

The first Farrer Memorial Scholar was Mr. W. L. Waterhouse, B.Sc. (Agr.), who held the scholarship in 1912–13, and undertook valuable research work at Sydney University into the effects of superphosphate on our wheat-yields.* The scholarship was not awarded in 1914, but in 1915 it was offered to Mr. W. R. Birks, B.Sc., of the New South Wales Department of Agriculture. Mr. Birks, however, elected to join the A.I.F. for active service abroad, and was thus not able to avail himself of the scholarship.

During the war no award was made, but the Farrer Research Scholarship for 1919 was awarded to Mr. J. P. Shelton, scientific cadet in the Department of Agriculture, for two years' research work at Cambridge and an American University, with further extension of the scholarship if necessary. It is of interest to note that Mr. Shelton held the first Government Farrer Scholarship at Hawkesbury Agricultural College. In the year in which he secured his diploma he was dux of the college. He then secured a scientific cadetship in the Department of Agriculture, and in due course obtained his degree of B.Sc. (Agr.) Mr. Shelton returned from America in 1921, and is now employed in plant-breeding work in the Department, so that the utmost value is being obtained from his research work abroad.

No further award of the scholarship was made, but the trustees propose inviting applications for another research scholar at an early date.

A short statement by Mr. J. P. Shelton, B.Sc. (Agri.), Farrer Research Scholar, gives a brief and interesting review of his scientific investigations and experiences in England and the United States :—

On being appointed Farrer Research Scholar for 1919, I left for England in June of that year in order to take up work with Professor Biffen, the noted English plant-breeder. The British Ministry for Agriculture has for the past fifteen years maintained at Cambridge University a national plant-breeding Institute of which Professor Biffen is director.

The institute is charged with the work of plant-breeding and selection in cereals, potatoes and root crops for the whole of England. It developed from work undertaken privately by Professor Biffen in 1901 as an investigation of the application to cereals of

* The results of this investigation were published as a Special Science Bulletin by the Department of Agriculture (Science Bulletin, No. 10, July, 1913, "The Effect of Superphosphates on the Wheat-yield in New South Wales").

the recently discovered Mendelian principles. The results obtained in these purely scientific experiments convinced Professor Biffen that the way lay open for him to solve two of the problems of the English wheat-farmer—the breeding of a rust-resistant wheat and the combination within one variety of the two characters, yield and flour-strength. At the time the latter problem was said to be impossible of achievement ; indeed it was believed by many that the English climate absolutely precluded the successful growing of a high strength wheat in the country.

The English millers, a number of leading farmers and landowners, and finally the British Ministry of Agriculture, became interested in Professor Biffen's work, and thence resulted the endowed Plant Breeding Institute, which the next generation of English farmers will couple with Rothamsted Experiment Station. So far three varieties of wheat have been bred, all of which to-day are largely and increasingly grown. The application of modern science has achieved fine success, although wheat has been constantly improved in England during the last century and a half.

At this Institute it was my privilege to study, during a period of fourteen months, the bearing of Mendelian science and modern genetics upon the problems of the plant-breeder, and through him the problems of the farmer. As the Institute is connected with the Cambridge University I took full advantage of the opportunity to study those phases of botanical science and genetics upon which Professor Biffen has based his plant-breeding methods.

After the valuable experience at Cambridge the Farrer trustees gave me the opportunity of equally valuable experience in the United States ; and under the terms of the scholarship I proceeded in October, 1920, to St. Paul, Minnesota, to commence work at the Agricultural Experiment Station there. This station is maintained in connection with the Minnesota State University, and is the leading wheat-breeding centre in the United States. It was here that the so-called "Centgener" method of selection was originated in 1892. Some pronounced success resulted from the intensive selection adopted for several years ; but now there has come the realisation that when definite problems have to be solved, the methods of cross-breeding adopted by Professor Biffen and largely by our own breeder, Mr. Farrer, must be adopted.

The Minnesota plant-breeders have their own local problems to meet. The most important is that of rust-resistance. Results and data obtained there will in this connection undoubtedly have a definite bearing upon the production of rust-resistant varieties in Australia.

A particularly interesting phase of my time at Minnesota was the study of the organisation and general methods of agricultural investigation, education, and propaganda in the United States. The average opinion of the man in the street, be he farmer or no, is that the immense sums of money spent by the Federal and State authorities, and the independent Experiment Stations upon the development of agricultural production, is entirely worth while. That opinion is based on the results he sees and feels for himself.

Although primarily concerned with wheat-breeding, the Farrer trustees, not unmindful of the wide application of the plant-breeder's work, permitted me to spend some time in Hawaii. There I investigated the work of the Plant-breeder, with such tropical crops as sugar-cane. All research work in the Hawaiian Islands is done by an institute maintained entirely by an association of sugar-planters whose interests are at stake. These primary producers are satisfied to spend £50,000 per annum upon the expert investigation of their problems.

As one who knows the opinion held both in England and America concerning the high standard of Farrer's work, and the value accruing through the cultivation of his varieties, not only here, but increasingly in the United States and in India, I cannot refrain from saying that Farrer deserves a nobler memorial than he has at present. Were the world to know fully the facts of the case, they would think strangely of Australia's gratitude to the man who made it possible for this country to be in 1898 a non-exporting wheat country, and in 1922 one of the controlling factors in the European wheat market.

A Farrer Plant-breeding Station in the heart of the main wheat belt, permanently endowed, and controlled by a responsible public trust, should not, and need not, be beyond realisation. As a national investment, it would be worth while.

CONCLUSION.

It will be seen from the foregoing that Farrer, in the particular line which he chose for himself, was a pioneer who is entitled to our gratitude to as great an extent as those pioneers of our other primary industries who have put wool-production, cattle and horse breeding, dairying, meat exportation, wine-production, and other national industries on a firm basis, possessing possibilities of unlimited expansion in the future.

He never obtained, nor did he ever seek, the slightest monetary advantage from his labours. The fruit of his brain was given freely and generously to all. The single object which actuated him during the twenty years he devoted himself to this work was the benefiting of the wheat-grower. With this object he set himself the task of creating improved varieties which should ensure a certain and profitable return, varieties whose cultivation would extend the area at present under crop, and which should be distinguished by their increased commercial value. He was successful beyond expectations in all these directions. Previous wheat-breeders had succeeded in producing a few varieties of outstanding excellence in some particular characteristic. Farrer produced scores of varieties of the most varied characteristics, from which the wheat-grower could select with confidence one or more pre-eminently suited to his climatic conditions, or to the objects for which he grew them.

This success was rendered possible by the peculiar equipment of Farrer's genius, his scientifically methodical brain, his untiring energy, his minute and conscientious attention to detail, and above all his unselfish singleness of purpose and the lofty ideals which he set before himself.

It would be a thousand pities if we allowed the memory of this great Australian to perish for want of proper recognition.

Is it true that his monument is set up in nearly every ripening field of wheat in this and the other States, but it must be anticipated that though Farrer wheats are now at the height of their popularity they will no doubt be replaced in general favour by varieties which will be produced in the future, largely as the result of his own labours.

The idea of commemorating Farrer's work and continuing it along the lines of which he was the pioneer was in the minds of those who first instituted the Farrer Memorial Fund. The response was rather disappointing, and it has only been by the exercise of the greatest economy that the trustees have been able to do what they have done without encroaching on the capital of the fund.

It is too much to hope that there exists a sufficiently high appreciation of Farrer's work, a sufficient sense of gratitude for his achievement, to bring about an increase to the fund, so that instead of its being only possible to assist in the training of one or two Farrer scholars in the course of several years, the trustees may be in a position to award the scholarship annually and to have more than one Farrer scholar completing his training at the same time?

Subscribers may be confident that the fund will always be utilised in furthering the ideals which inspired Farrer, and in a manner which would have been approved of by him were he alive.

I should like to thank (in addition to those who have contributed to the foregoing and whose names appear in it) Mr. J. T. Pridham, Farrer's successor, and Mr. G. W. Norris, who was at one time Farrer's assistant, for their friendly help.

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